HVAC SYSTEM DISPLAY

Background of the Invention

This invention relates to the manipulation of electronic files used to visually display images produced by a control associated with a heating, ventilating, and air conditioning system.

The amount of content that needs to be displayed by a control associated with today's heating, ventilating, and air conditioning systems is increasing rapidly. This is occurring while at the same time there is an emphasis on cutting the costs of electronic components used in such embedded controls. In particular, the amount of content to be displayed impacts the amount of memory needed in these controls.

Summary of the Invention

The present invention provides a set of processes for compressing and decompressing bitmapped picture files. The files preferably contain information to be displayed by a control associated with a heating, ventilating, and air conditioning system (hereinafter referred to as an HVAC system).

The process for compressing data begins with an examination of the first bitmapped pixel in a bitmapped file that is to be compressed. A programmed processor , either within the control or separate therefrom, counts the number of consecutive pixels having the same state as the first pixel. This number of consecutive pixels is used to generate a numerical representation of the counted number of pixels. The processor continues to analyze successive numbers of pixels of particular binary states and generating numerical representations as to the number of so counted pixels until the last pixel of a bitmapped picture file data is analyzed. The resulting compressed file consists of the value of the first pixel followed by a number of bytes containing a numerical representation of the number of pixels having binary values equal to the first pixel followed by further numbers of bytes having numerical representations of

the number of pixels having first one binary value and then the other. This compressed file is stored in the memory of the control associated with the HVAC system.

The stored file is read from memory when it is to be displayed. The reading and decompressing of the stored file is the reverse of the compression of the file. In particular, the value of the first pixel is noted. A number of further bytes of information are thereafter analyzed to determine the appropriate number of pixels of the same value that are to be produced. The pixel value is changed and a number of further bytes of information are thereafter analyzed to determine the appropriate number of pixels of the changed pixel value that are to be produced. The changing of pixel value followed by an analysis of further bytes of information to determine the appropriate number of pixels of the changed pixel value to be produced is repeated until there are no more bytes of information to be analyzed.

In a preferred embodiment, the numerical representation is computed in the compression process by dividing a counted number, N, of consecutive pixels having a given binary value by a numerical constant. The numerical constant preferably has a mathematical relationship to the amount of bits in a byte of information. The resulting quotient is examined for having any remainder. If no remainder, then the resulting quotient having an integer "n" will be used by the processor to store "n-1" bytes having a zero value followed by a byte containing the numerical constant. If on the other hand, there is a remainder "r", then the processor stores "n" bytes having a zero value followed by a byte of information containing the value of "r".

Brief Description of the Drawings

For a fuller understanding of the present invention, reference should now be made to the following detailed description taken in conjunction with the accompanying drawings wherein:

Figure 1 is a block diagram of a processor within an HVAC system that processes electronic files from a memory for visual display;

Figure 2 is a flow chart of a process used to compress an electronic file produced during the control of the HVAC system of Figure 1; and

Figure 3 is a flow chart of the process used to decompress the read file from the memory of Figure 1 before displaying an image on the display in Figure 1.

Description of the Preferred Embodiments

Referring to Figure 1, a processor 10 is operatively connected to an HVAC system 12 as well as to a memory 14 and a display 16. The processor 10 is operative to produce a file of information concerning the operation of the HVAC system 12. This file may be a bitmapped file for use in displaying the information on the display 16. The bitmap file is first compressed before being stored in the memory 14. The thus compressed bitmap file is thereafter available for reading and display on the display 16.

It is to be understood that bitmap files may be compressed and stored into the memory 14 by other than the processor 10. In this regard, there may be files of bitmapped information stored in the memory 14 that are compressed by a processor external to the control of Figure 1 and thereafter stored in the memory 14.

Referring now to Figure 2, the process used by either the processor 10, or a processor external to the control of Figure 1, to compress the bitmap file is illustrated in flow chart form. The process begins with a step 20 wherein the processor opens a bitmap file of data and reads the file data. The processor proceeds in a step 22 to store the binary state of the first pixel. The processor next proceeds in a step 24 to count the number of consecutive pixels having the same binary state as the first stored pixel. This counted number is set equal to "N". The processor proceeds in a step 26 to

compute the quotient of "N" divided by the constant "255". It is to be noted that the constant "255" is the largest base ten number defined by an eight bit byte which is the byte size used in the invention.

Referring to step 20, the integer portion of the resultant quotient is set equal to "n". The processor also notes the remainder "r" resulting from the division of "N" by the constant "255". The remainder "r" is equal to the counted number of pixels "N" minus the integer "n" multiplied by the constant "255". The processor proceeds in a step 28 to inquire as whether the remainder "r" is equal to zero. In the event that "r" equals zero, the processor proceeds to step 30 and stores "n-1" bytes of zero value followed by a byte having a value equal to the constant "255". On the other hand, if the remainder "r" does not equal zero, then the processor proceeds in a step 32 to store "n" bytes of zero value followed by a byte having a value equal to the remainder "r".

The processor proceeds out of either steps 30 or 32 to a step 34 and changes the saved state by one before proceeding to step 36 to inquire as to whether all input file data have been processed. In the event that all file data has not been processed, then the processor proceeds along the no path back to step 24 wherein a count is made of the next occurring pixels in the input file that have the saved state of step 34. The count of pixels in the saved state is set equal to "N" in step 24. The processor proceeds in steps 26 through 32 to again compute the quotient comprising the integer "n" and the remainder "r" before storing the required number of zero bytes and either a byte equal to "255" or "r" in either step 30 or 32 and again changing the saved state by one in step 34. The processor always proceeds to step 36 after executing step 34. It is to be appreciated that all input file data will have been processed at some point. When this occurs, the processor proceeds from step 36 to step 38 and stores the resulting compressed file in memory 14.

The stored file will preferably consist of a first byte of information containing the value of the first pixel. This will be followed by a number of bytes which when taken together define the numerical representation of the number of pixels having the value

of the first pixel. These bytes will be followed by a further number of bytes which when taken together define the numerical representation of the number of next occurring pixels having the opposite binary value to that of the first pixel. These bytes will be still further followed by a still further number of bytes which when taken together define the number of next occurring pixels having the opposite binary value to that of the previously counted pixels. The numerical representations in each instance will be the integer "n" expressed in a coded number of zero bytes followed by either a byte equal to "255' or to "r" depending on whether or not there is a remainder of "r".

Referring now to Figure 3, the process used by the processor 10 to read the compressed file stored in memory 14 is illustrated. This process begins with a step 40 wherein the processor reads the state of the first stored pixel in a step 40. The processor proceeds in a step 42 to retrieve the next data byte stored in memory 14. It is to be appreciated that this next data byte will either be a byte having a value of zero or a byte containing the constant "255" or the remainder "r". The value "X" of the byte is read in step 44 and examined as to whether it is equal to zero in a step 46. In the event that the byte value "X" is zero, then the processor will set the next 255 pixels equal to the current pixel state in a step 48. The processor will proceed out of step 48 to a step 50 and change the pixel state by binary one. The processor thereafter proceeds in step 52 to inquire as to whether all data bytes have been processed from memory 14.

Assuming that there are more data bytes to be processed, the processor will return to step 42 and retrieve the next data byte. The value "X" of the byte is read in step 44 and examined as to whether it is equal to zero in a step 46. If the value "X" of the numerical representation in the byte is not equal to zero, then the processor will proceed in a step 54 to set the next "X" number of pixels equal to the current pixel state. In this regard, the number of pixels set equal to the current pixel state will either be the numerical constant "255" or it will be "r".

The processor will proceed out of step 54 and change the pixel state by binary one in a step 56. The processor thereafter proceeds in step 50 to inquire as to whether all data bytes have been processed from memory 14. When all such data bytes have been processed, the processor will proceed in a step 52 to forward the decompressed bitmapped file for display on the display 16.

It is to be appreciated that a preferred embodiment of a set of processes has been disclosed for compressing and decompressing bitmap files of data that may be used for displaying visual images associated with the operation of an HVAC system. Alterations and modifications to the thus disclosed processes may occur without departing from the scope of the invention. Accordingly, the forgoing description of the preferred embodiment is to be limited only by the following claims and equivalents thereto.